IN THE SPECIFICATION:

Please amend the paragraph on page 5 at lines 2-5 as follows:

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Figs. 1(A)-(B) are top and side cross-sectional views of a monocrystalline silicon wafer with a pyramidal cavity micromachined therein by wet anisotropic etching of the prior art~~.~~, while Figs. 1(C)-(L) are side cross-sectional diagrams illustrating cavities etched in a silicon wafer by various series of processing steps, some according to various preferred embodiments of the present invention.

Before the paragraph that begins on page 6 at line 28 and ends on page 7 at line 3, please insert the following paragraphs at the beginning of the section entitled "DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS":

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Before describing in detail the preferred embodiments of the present invention, it is worthwhile to further discuss the effects of the use of wet anisotropic etching to form a cavity in a silicon wafer and to make comparisons to situations in which wet anisotropic etching is not performed until after an initial cavity has been formed in the silicon wafer using some etching technique other than wet anisotropic etching. This discussion, along with the accompanying illustrative figures, will serve to clarify description of the preferred embodiments.

As discussed briefly in the Description of Prior Art, the effect of wet anisotropic etching on the geometry of silicon structures is characterized by the fact that the etch rate in <111> crystallographic directions – that is, in directions

perpendicular to {111} planes in the crystallographic structure of silicon – can be several hundred times less than in other directions, for example, <100> directions (i.e. in directions perpendicular to {100} planes). Hence, the shape of any cavity formed in silicon by wet anisotropic etching is essentially determined by {111} planes since these serve to act as "walls". Since {111} planes are at an angle with respect to the surface of, for example, (100) or (110) silicon wafers (the two most common types used in silicon micromachining), these {111} planes (which act as walls) limit the etch depth realizable through openings defined on the surface of the wafer by the use of etching masks. The shape of a cavity is determined by: the size and shape of the opening, its orientation with respect to crystallographic directions, and {111} planes.

A consequence of this observation is that the etch depth achievable using wet anisotropic etching is limited by the size of the opening on the wafer surface and {111} planes. This observation is illustrated in Figs. 1(C)-(D). In Fig. 1(C) is shown a cross-sectional view of a (100) silicon wafer 12. A square opening 14 has been defined on its surface with the layout of the etching mask 13 being such that the edges of the square opening are aligned with <110> crystallographic directions. The dashed lines show two {111} planes 18a having the smallest angle $\theta_{\{111\}}$ with respect to the surface of the wafer in the region of the opening. Since wet anisotropic etching in directions perpendicular to {111} planes can be hundreds of times slower than in, say, directions perpendicular to {100} planes (which are parallel to the surface of a (100) wafer), these dashed lines also represent the approximate position of the walls of the cavity which

would be formed using wet anisotropic etching; this resulting cavity 5 is pictured in Fig. 1(D). The depth of this cavity is H_{111}. In order to increase the achievable etch depth it would be necessary to increase the size of the opening 14, thereby increasing the overall size of the structure and reducing the total number of such structures batch-fabricated on a single silicon wafer. This results in a higher cost of manufacturing.

One of the main objects of the present invention is to mitigate this limitation on achievable etch depth using wet anisotropic etching given an opening of fixed size. Once such an opening is defined on the surface of the wafer, if some etching technique other than wet anisotropic etching is first used to form an initial cavity, it may be possible to achieve a greater etch depth than would be achievable using wet anisotropic etching alone. Whether the achievable etch depth will be increased or not will depend on the angle between the surface of the wafer and the walls of the initial cavity. If this angle is smaller than the smallest angle between the wafer surface and {111} planes then the etch depth will not be increased. However, if the angle between the wafer surface and the walls of the initial cavity is greater than the smallest angle between the wafer surface and {111} planes then the achievable etch depth will be increased. These observations are elucidated in Figs. 1(E)-(H) and Figs. 1(I)-(L) which we now discuss.

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In Fig. 1(E) is shown the same cross-sectional view of a (100) wafer 12 with the opening 14 defined as in Fig. 1(C). However, here an initial cavity 6 has been formed using some etching technique other than wet anisotropic etching.

The walls of this cavity are such that the (tangents to the) walls at the wafer surface form an angle θ_1 with respect to the wafer surface in the region of the opening. Note that $\theta_1 < \theta_{\{111\}}$, where $\theta_{\{111\}}$ is the smallest angle between the {111} planes 18a and the surface of the wafer 12 in the region of the opening 14. If wet anisotropic etching is now performed etching will proceed in all directions normal to the surface of the initial cavity, but the rate is still several hundred times slower in directions perpendicular to {111} planes. Hence, the final form of the cavity will be as shown in Fig. 1(F); that is, it is identical to the cavity 5 shown in Fig. 1(D)

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In Fig. 1(G) is again shown a cross-sectional view of a (100) wafer 12 with the opening 14 defined as in Fig. 1(C). An initial cavity 7 has been formed using some etching technique other than wet anisotropic etching. The walls of this cavity are such that the (tangents to the) walls at the wafer surface form an angle θ_2 with respect to the wafer surface in the region of the opening 14. Unlike in Fig. 1(E), the angle between the walls of the initial cavity and the wafer surface is greater than the smallest angle between {111} planes 18a and the wafer surface in the region of the opening; that is $\theta_2 > \theta_{\{111\}}$. In this case subsequent use of wet anisotropic etching will result in a cavity 8 of the form shown in Fig. 1(H). The walls of the cavity again correspond to {111} planes 18b, but these are different {111} planes than those (18a) which defined the cavity in Figs. 1(D) and (F). The "kink" in the walls near the opening 14 results from still other {111} planes 18c which have served to retard etching in <111> directions. Note that, although the size of the opening 14 in Fig. 1(G) remains identical to that in Figs. 1(C) and (E),

the overall depth H_+ of the cavity 8 is greater than that (i.e. cavity 5, which has a depth of H_{111}) achieved using wet anisotropic etching without an initial step of etching using a technique other than wet anisotropic etching.

The advantages accrued through the use of this method of fabricating semiconductor microstructures are not restricted to (100) silicon wafers. Although somewhat more complicated to visualize, consider a (110) silicon wafer. In this case the {111} planes do not all have the same angle with respect to the surface of the wafer. In Figs. 1(I)-(L) are shown analogous figures to those appearing in Figs. 1(E)-(H) except that here the wafer is a (110) silicon wafer, rather than (100), and the opening is no longer square. Instead, the opening has the shape of parallelogram with sides parallel to the <110> and <211> crystallographic directions. The cross-section shown is along a <100> direction.

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In this case the angle between {111} planes and the surface of the wafer is not unique. Some {111} planes 11a are perpendicular to the surface of the wafer (i.e. they form an angle $\theta_{\{111\}A}$ = 90 deg with the wafer surface) while others 11b are at an angle $\theta_{\{111\}B}$ with the respect to the wafer surface, where $\theta_{\{111B\}}$ is different than the angle $\theta_{\{111\}}$ of the {111} planes 18a with the respect to the (100) wafer surface in Figs. 1(C)-(H). Independent of the orientation of the {111} planes, the etching rate for wet anisotropic etching remains several hundred times slower for directions perpendicular to {111} planes.

In Fig. 1(I) an initial cavity 9 has been formed using a technique other than anisotropic etching. The walls of this cavity are such that the (tangents to the)

walls at the wafer surface form an angle θ_3 with respect to the wafer surface in the region of the opening. Note that $\theta_3 < \theta_{\{111\}A}$ and $\theta_3 < \theta_{\{111\}B}$, where $\theta_{\{111\}A}$ and $\theta_{\{111\}B}$ are the smallest angles between the {111} planes 11a and 11b, respectively, and the surface of the wafer in the region of the opening. If wet anisotropic etching is now used the shape of the resulting cavity 10 will be as shown in Fig. 1(J); that is, it is has depth H'_{111} and is identical to the cavity which would be formed with wet anisotropic etching without an initial non-wet anisotropic etching step.

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However, if, as in Fig. 1(K), an initial cavity 17 is formed by an etching technique other than wet anisotropic etching such that the angles between the wafer surface and the tangents to the walls at the wafer surface in the region of the opening are greater than the angles between the various {111} planes 11a and 11b and the wafer surface in the region of the opening, then the final shape of the cavity 19 after the subsequent use of wet anisotropic etching will have the form shown in Fig. 1(L). The cavity is now determined by the (111) planes 11c-f. With the use of an initial etching technique other than wet anisotropic etching the depth H_+ of the resulting cavity 19 is greater than that achievable using wet anisotropic etching only (i.e. depth H'_{111}), even though the shape and size of the initial opening has remained unchanged.

It is apparent from the preceding discussion and the related figures that the formation of an initial cavity using some etching technique other than wet anisotropic etching can be highly beneficial in terms of increasing the achievable

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etch depth given an opening of fixed size. This is now illustrated further in the context of the preferred embodiments of the present invention.